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Physical Factors in the Ecology of Caripito, Venezuela.¹

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(Plates I & II; Text-figures 1-5).

INTRODUCTION.

The Forty-third Expedition of the Department of Tropical Research of the New York Zoological Society had its headquarters at Caripito, in northeastern Venezuela. Under the direction of Dr. William Beebe the expedition left New York for Venezuela on February 12, 1942, and returned on September 20, flying both ways on Pan American planes. The elaborate outfit made a safe transit by sea on the Standard Oil tanker *Aruba*. The members of the staff were Jocelyn Crane, Research Zoologist; George Swanson, Artist; Henry Fleming, Entomologist; and Mary Vander Pyl, Associate.

Invaluable assistance and support were given by a grant from the Committee for Inter-American Artistic and Intellectual Relations, by the Standard Oil Companies of New Jersey and Venezuela, and by four Trustees of the Zoological Society, Laurance Rockefeller, Childs Frick, Herbert L. Satterlee and George C. Clark.

Field work was carried on in the jungles about Caripito from February 19 to September 2. The objects were to make life history and ecological studies, to secure extensive color motion picture records of wild life, to record the reactions of animals to the very distinct dry and wet seasons, and to make detailed observations through high power binoculars of 12, 20 and 40 diameters.²

Five lectures with motion pictures were given in Caracas and Caripito, and constant, constructive relationships were initiated and maintained with Venezuelan scientists and institutions.

The object of the following brief ecological survey of this area is to afford a background for forthcoming zoological studies and also offers direct comparison with the environment of Kartabo, British Guiana,

528 kilometres (330 miles) to the southeast. Under typical tropical rain forest conditions we have devoted, in the past, eight expeditions to researches in the vicinity of Kartabo.

There is very little in literature concerning the ecology of the Caripito area, and until I arrived I had expected the general conditions to approximate those at Kartabo, about the same distance away as Buffalo is from New York City. I was completely mistaken, and found, as will be seen, that Caripito possesses a curious admixture of several distinct floral and faunal zones, all of them quite atypical of a true tropical rain forest.

For direct comparison with the ecological conditions existing at Kartabo, refer to Beebe, "Studies of a Tropical Jungle," *Zoologica*, VI, 1, 1925, pp. 1-193.

GEOGRAPHICAL POSITION.

Caripito is situated in northeastern Venezuela in the extreme north of the State of Monagas, in $10^{\circ}09' N.$ Lat., and $63^{\circ}05' W.$ Long. The following distance lines of radiation will serve to complete its orientation:

	Kilos.	Miles
North to Caribbean Sea	67	42
Northeast to Port-of-Spain	182	114
East to Gulf of Paria	50	31
Southeast to Kartabo, British Guiana	528	330
South to Quiriquire (by road)	27	17
South to Maturin (by road)	43	27
South to Ciudad Bolívar & Orinoco River	223	140
West to Caracas	434	271
Northwest to Cumaná	127	80
Northwest to New York	3570	2233

GEOLOGY.

A geological map of northeastern Venezuela shows Caripito at the very edge of two very unlike formations. To the west and north are hills and mountains; solid outcroppings of Upper and Lower Cretaceous

¹ Contribution No. 665, Department of Tropical Research, New York Zoological Society.

² Two contributions have already appeared: Beebe, W., "Pattern and Color in the Cichlid Fish, *Aequidens tetramerus*," *Zoologica*, XXVIII, 3, 1943, pp. 13-18; Crane, J., "Crabs of the Genus *Uca* from Venezuela," *Zoologica*, XXVIII, 7, 1943, pp. 38-44.



Text-fig. 1. Faunal regions of northern South America. (After Cabrera and Yepes).

series of grits, limestones and shales. Away from the foothills, to the south, the Pleistocene and Recent alluvial deposits of the llanos clays, sands and gravels become dominant. These last formations are characteristic of immense extents of territory bounded by the Orinoco Delta on the east and hundreds of miles of the Orinoco River itself, as well as extending varying distances to the south of this river in the direction of the British Guiana boundary.

According to Schuchert (1935, "Historical Geology of the Antillean-Caribbean Region") Caripito has been submerged a number of times: in the Middle Pennsylvanian, Middle and Upper Cretaceous, and throughout the Eocene, Oligocene, Miocene, Pliocene and Pleistocene.

FAUNAL REGIONS.

The most recent as well as the most generalized segregation of faunal regions in northeastern South America is that in "Mamíferos Sud-Americanos," published in Argentina by Dr. Angel Cabrera and Dr. José Yepes. In the colored *Mapa de los Distritos Zoogeográficos de América del Sur* they show the arrangement which is presented in Text-figure 1. Almost all of central and northern Venezuela as well as corresponding portions of Colombia are designated as the Savanna Region (*Distrito Sabanico*), whereas all the territory of Venezuela well south of the Orinoco, the Guianas and a considerable part of Brazil, are included in the Amazonian Region (*Distrito Amazonica*).

Future definite and detailed studies of organisms of this region will enable us to

elaborate and delimit more accurately these faunal zones.

PHYSICAL GEOGRAPHY.

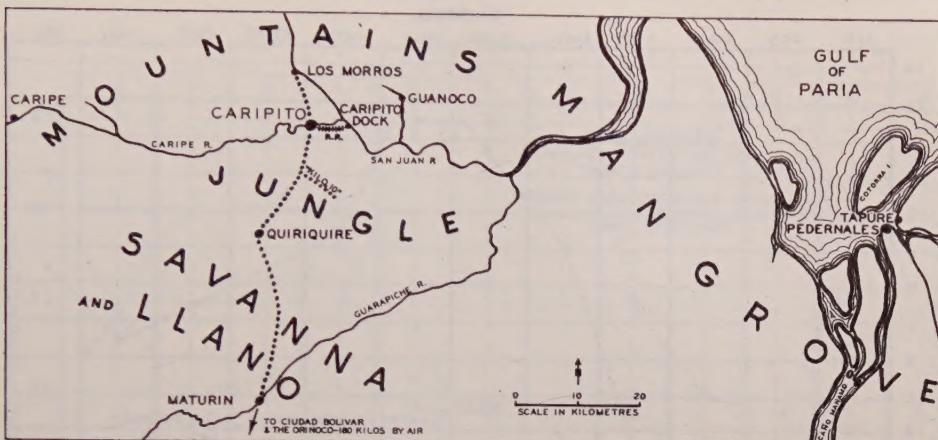
(Text-fig. 2; Pl. I; Pl. II, Fig. 3).

From the southwest and around through north to northeast of Caripito the land rises rather abruptly into hills and mountains. Some of these are close; others, to the west, far away, show horizon silhouettes up to almost 5,000 feet.

The Rio Caripe winds from the west to and through Caripito, and on eastward to its junction with the much larger San Juan. This latter also curves around from the north to the east and on to its ultimate merging with the waters of the Gulf of Paria, looking across to Trinidad and the Paria Peninsula.

From any elevated position in Caripito the horizon seems everywhere bounded by jungle, but this is deceiving, for at its best it is not comparable with the majestic primitive rain forest of British Guiana. The most dominant human mark on all this region is the excellent asphalt, oil and dirt highway which begins at the bank of the San Juan and runs almost due south to Quirquire and Maturin. This roughly bisects the region in more ways than one.

To the west and south we find the apparently solid jungle becoming lower and lower, giving way at last to the grassy deserts of the savannas and llanos. There has been a good deal of confusion in the use of these two anglicized terms. By llanos we mean flat, grassy lands wholly lacking in



Text-fig. 2. Physical geography of the Caripito region.

trees except along river courses. Savannas have a thin growth, usually widely spaced, of chaparros and other low trees, this type being very evidently intermediate between extremes of regional vegetation.

The llanos, as I have said, are characteristic of immense areas in central Venezuela, and represent a type of country wholly unlike anything in the Kartabo region. The absence of adequately fertile humus and paucity of such necessary elements as calcium, plus the sterile clays and sands make plant life to any great extent an impossibility, except for quick growing grasses, which soon die and last until burned over, or replaced by the succeeding year's meagre crop. The only tree in the savanna near Caripito is the dwarf and agonized chaparro, *Curatella americana*, which thrives or rather exists in this area, and at its best seems more dead than alive. In the llanos proper, another factor working against any appreciable amount of vegetation is the wide-spread inundation during the rains, permitting growth only of water-resistant plants.

To the east of Caripito and of the highway, we encounter the first mangroves, and these increase in extent and purity of culture until, as we proceed down the Rio San Juan, the last palms and other growths die out. Finally, there is left salt or brackish tidal mud in which only mangroves are able to hold their own. This scenery is characteristic of the entire Orinoco delta.

The jungle itself, chiefly to the south and southeast of Caripito, is confusing at first. There seems to be no reason why these *selvas* should not be as tall, as fine, as luxuriant as those of Kartabo, but they simply are not. Occasionally there is a tree so tall, so hung with lianas, that it recalls the finest of the

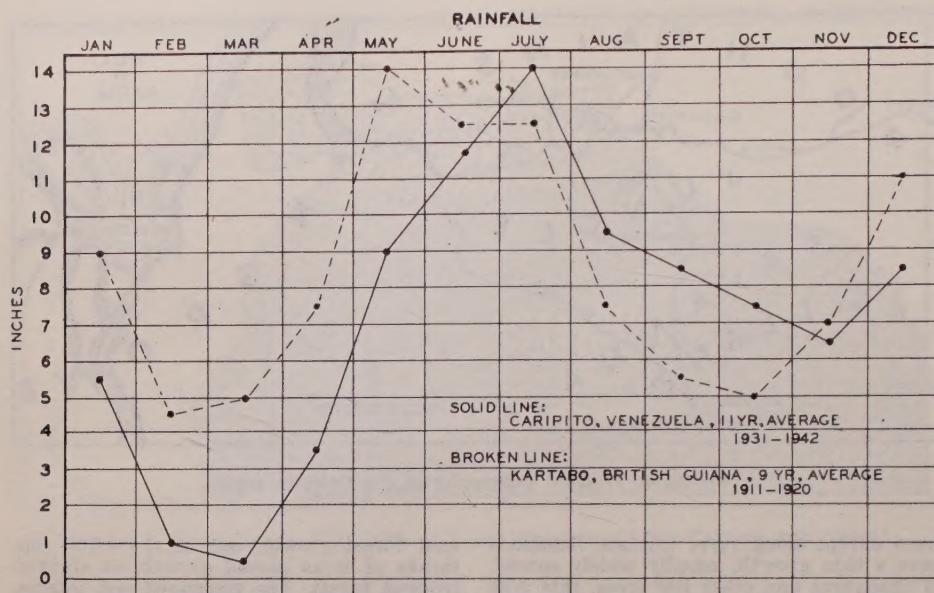
rain forest growth, but on the whole one thinks of it as second growth, as stunted tropical forest. The prolonged and intense drought of the dry season does not seem sufficient to explain this condition. The soil and subsoil are relatively thin but so also is the soil of Guiana. The real answer did not come until a full month or more of the wet season had past, when we found that our so-called jungle had all become first marsh, then swamp, and finally actually inundated. Most of our collecting ground was permanently under water, and this for months.

SEASONS.

(Text-figs. 3-5; Pl. II, Fig. 2).

The most noticeable thing about the seasons at Caripito is the very long, very pronounced Dry Season. This embraces January, February, March, April and sometimes early May. In these months the rainfall varies from a quarter of an inch (as in March, 1942) to as much as an average of 5.64 in May. Variations occur, as in 1942 when a single downpour of 2.1 inches on the first day of January brought up the month's average to a false rain figure. May of 1942 with 12.35 inches was definitely thrown into the Long Wet Season category.

This second period normally includes June, July, August and September, all usually with 10 to 17 inches of rain. Then comes slackening during October and November but with no average below 6.73 inches, and rising somewhat in December. This short October-November drop in rain can hardly be considered a second Dry Season, compared with that in the early part of the year or the very definite one which exists in the Kartabo year. Variations in



Text-fig. 3. Comparative rainfall of Caripito and Kartabo.

successive years may shift or completely obliterate this lessened precipitation.

So, in general, we find at Caripito two main seasons: one very dry of four months or slightly more, and the other with a considerable rain average and a sudden high peak in July and another lower one in December.

The difference between the general annual rainfall of Kartabo and Caripito, 100 and 80 inches respectively, would not in itself be sufficient to explain any extreme differences in flora or fauna, but the different distribution into two radically unlike seasons, instead of four less strongly marked ones, may well be considered to be responsible in part for fundamental ecological differences.

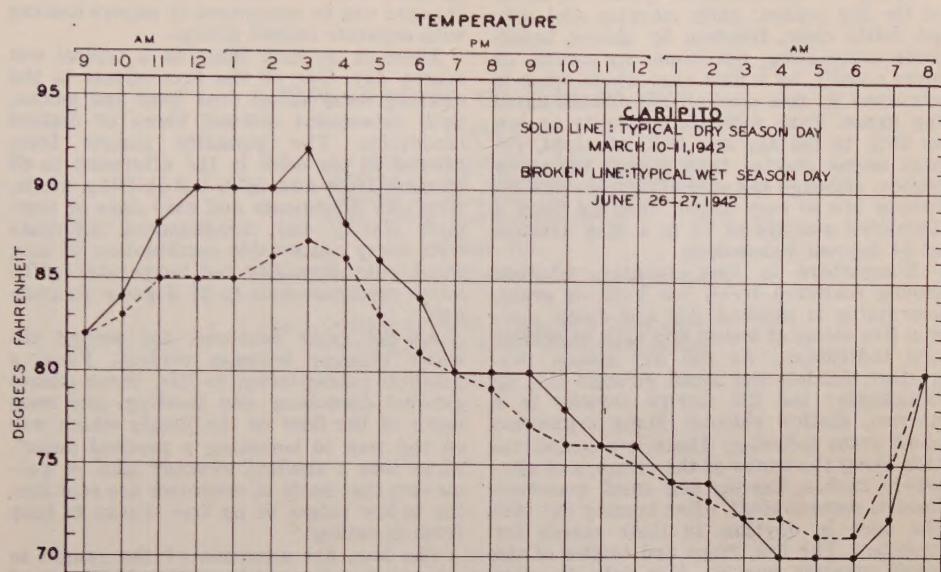
The Caripito data are based on records extending over eleven years, and the general averages are reasonably well balanced. But the extremely *local* character of the rains and the seasons is shown by comparison with neighboring localities. Caripito rainfall is 80 inches. Quiriquire (27 kilometers south), 60 inches; Ciudad Bolivar (223 kilometers south), 35 inches. Yet these two places are in a direct line south, in the general direction of Kartabo. In each of their rainfalls the January-May dry season is much more pronounced, with low peaks of precipitation in June, July and August.

The number of days upon which rain falls does not differ radically in Kartabo and Caripito. An average Kartabo year shows

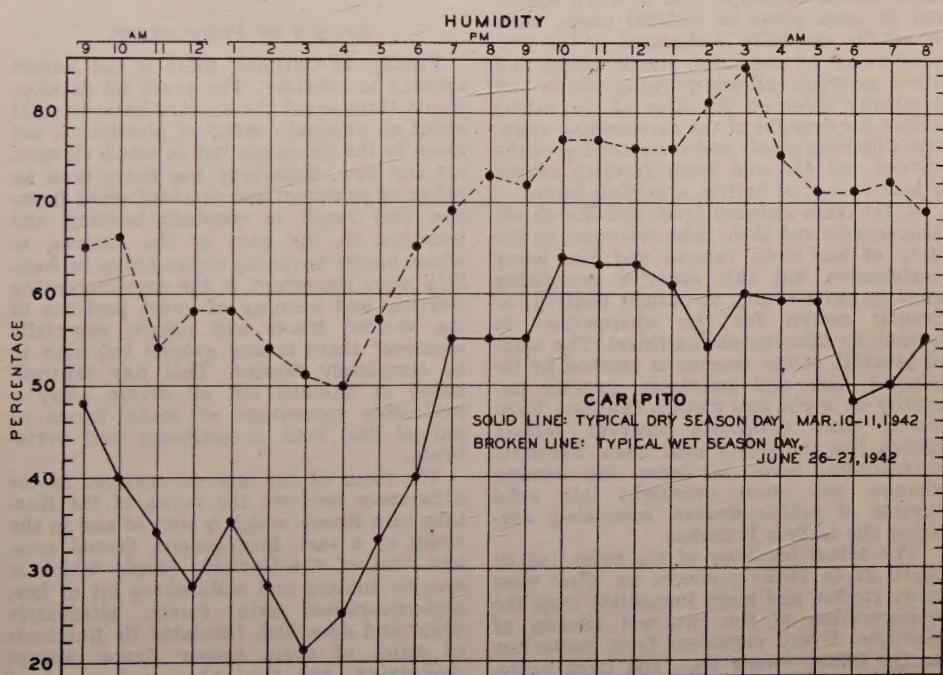
219 days of precipitation, or 59 per cent., and a corresponding Caripito year presents 197 rainy days, which is 54 per cent. of the year. To continue comparison of the same years, that at Kartabo shows May and June with 27 days of rain each, and February with a minimum of 6 days. Caripito has the maximum in May and July with 25 and 27 days respectively, while April has only 5.

Kartabo's maximum and minimum annual rainfalls are 117.75 and 77.11 inches; Caripito's are 104.15 and 61.13 inches. Monthly maximums are, Kartabo 22.34 inches in a May; Caripito 16.90 in July. Monthly minimums are, Kartabo .03 inches in an abnormal February, and Caripito .25 in a March.

The great variability in the character of the immediate environment of Caripito has already been pointed by the fact that less than 20 miles (27 kilometers) away, the annual rainfall is cut 25 per cent. We may develop this at even less distances. For example, the little narrow-gauge railway from Caripito to the loading wharf on the Rio San Juan is only 4.8 kilometers (3 miles) in length, yet at the river terminal there is an increase of 10 per cent. more rain. In returning to Caripito from a day's collecting in full sunshine at Tenth Kilometer on the Quiriquire road, we would often pass definite bands of heavy rainfall, such as three zones of saturated soil and jungle, alternating with two of dusty dryness.



Text-fig. 4. Temperature of typical Dry and Wet Season days.



Text-fig. 5. Humidity of typical Dry and Wet Season days.

A day in mid-March is typical of much of the dry season: early morning and sunset fairly clear, followed by almost immediate overcasting, sometimes by clouds, or more usually, by a dust haze which often is enhanced by thin smoke from distant burning grass. Even with the humidity as low as 22% in the day and 65% at night, the heat seems greater than during the rainy season, although the annual temperature extremes are so very slight, ranging from a December average of 78 to a May average of 84 degrees Fahrenheit.

Everywhere in open country, whether among scattered trees, low bush or grass, everything is parched, dry and dusty. Animal life seems at lowest ebb both in species and individuals. As the dry season progresses, ditches and small streams dry up completely; the Rio Caripe shrinks to a narrow, shallow channel. Many organisms show great suffering. There is a concentration along the banks of the rivers, and elsewhere snakes, lizards, and small mammals become more evident, often coming out into the open in daytime in their search for moisture. The fish, frogs and turtles of the small streams burrow deep into the last damp mud, if they cannot escape overland.

Precipitation of dew seems to keep the superficial, tree-top foliage of the jungle green but an unusual number of trees lose their leaves, although this is more apparent in open areas in isolated cases, than where the deciduity is obscured by the preponderance of evergreen jungle palms and other growths. All low-growing plants and especially those on the floor of the *selvas* reflect the drought of the surrounding country. Climbing plants and terrestrial growths shrivel and die, and every footstep causes a loud clatter of brittle, crackling leaves.

A few rare showers from mid-March on, arouse, now and then, false activities on the part of leaf-buds, insects and the lower vertebrates, but this abortive energizing ends in swift return to patient waiting, or frantic search for the wherewithal to quench an ever-increasing thirst. The actual preshift of the seasons is marked by increased haze and sultriness, greater humidity at night and distant thunder. Even before these symptoms, however, certain plants, like the yellow poui trees, *Tabebuia serratifolia*, seem to sense the coming change, and burst overnight into solid masses of golden flowers, completely covering the leafless branches.

The actual breaking of the rains (as on April 27 in 1942) produces an effect even more radical and more immediate than the inauguration of the two wet seasons of Kartabo. Every organism from bacterium to the tallest jungle tree, and from protozoan to jaguar and tapir, must be profoundly

affected. Specific details of some of these changes will be considered in papers dealing with separate animal groups.

There is no such thing as a typical wet season day. One of the first effects is the clearing away of all dust haze and smoke, with consequent distinct views of distant mountains. The humidity ranges from around 50 per cent. in the afternoon to 85 or more after midnight, but shifting winds, irregular downpours and rare days of complete clarity and cloudlessness, alternate with every conceivable combination of sun, cloud, rain, humidity and temperature. The latter rarely ascends to 87 degrees Fahrenheit.

As the rains continue, the second climatic extreme becomes evident. From a grateful resuscitation to life, there ensues gradual drenching and flooding, and soon much of the floor of the jungle which was on the way to becoming a parched desert, turns into a shallow, swampy lake, so permanent that hosts of creatures are sent fleeing to low ridges or up tree trunks to keep from drowning.

The low, flat situation of the jungle in general, together with an almost absence of drainage, explains this extreme result of the rains; and helps to account for the general faunal conditions here compared with those of the rain forest at Kartabo.

EFFECT OF POPULATION.

Finally, at Caripito, there is the human element to consider. The great oil developments throughout the country have brought about an unusual density of population, not alone in the oil camps but in small villages, old and new. Especially has there been an influx of squatters and resident small farmers. One result is constant hunting and trapping on the part of the natives, to whom hardly anything comes amiss as food. Still more important is the ever-increasing clearing and burning of great portions of the wooded tracts and jungle, especially wherever there is any ground too high to be completely flooded. This has exterminated or thinned out or driven away a noticeable percentage of many forms of animal life, both invertebrate and vertebrate.

The focus of our interest centered in the differences between the fauna of the Kartabo rain forest, which is part of and in the midst of a vast, homogenous, faunal area, and that of the Caripito jungle which is sharply limited and isolated—a bit of low, undernourished rain forest, alternately dried and drenched, insulated by hundreds of miles of open, grassy llanos, abrupt mountains, and the submerged world of mangroves.

EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1. Air view near Caripito, showing merging of jungle and savanna. (*Photograph courtesy of Standard Oil Companies of New Jersey and Venezuela*).

PLATE II.

Fig. 2. Bed of the Caripe River at height of dry season.

Fig. 3. Outlook to north of Caripito laboratory, showing Caripe valley and distant mountains.

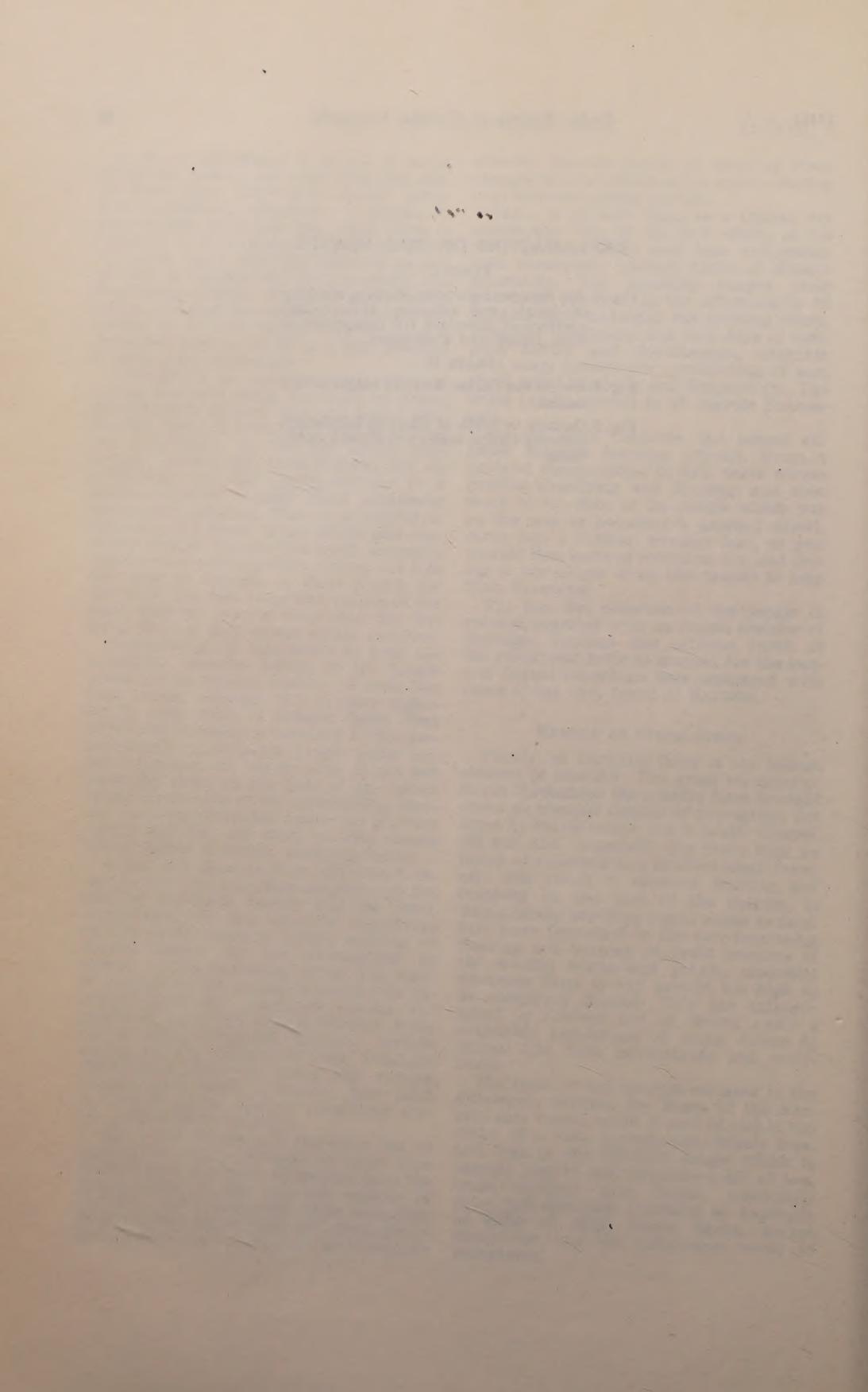




FIG. 1.

PHYSICAL FACTORS IN THE ECOLOGY OF CARIPITO, VENEZUELA.

BEEBE.



FIG. 2.



FIG. 3.

PHYSICAL FACTORS IN THE ECOLOGY OF CARIPITO, VENEZUELA.